

Trematode Parasites from the Dolphins of the Ganges, *Platanista gangetica* and *Orcella brevirostris*. By T. SPENCER COBBOLD, M.D., F.R.S., F.L.S., Correspondent of the Academy of Sciences of Philadelphia.

[Read May 4, 1876.]

[PLATE X.]

AN instructive coincidence in the pursuit of helminthology affords me the pleasure of bringing before the Society some noteworthy facts respecting two forms of fluke parasite*.

The special interest attaching to these insignificant creatures arises, in the first place, from the circumstance that they have been obtained from cetacean hosts that were not previously known to be liable to be infested by them. In the second place, both of the parasites have each only once before been seen by any observer; and in either case the original cetacean host is generically distinct from the hosts whence we have now obtained the parasites. Thirdly, the locality whence we have procured these entozoa is situated thousands of miles apart from either of the two regions in which the original specimens were discovered. Fourthly, the original localities yielding the specimens are themselves widely divergent from one another. Fifthly, and in either case, verification of the previously recorded facts has only been acquired after a lapse of many years. Lastly, our knowledge of the internal structure of both of the parasites, which was hitherto very limited, is now rendered tolerably complete, at least as regards the morphology and arrangement of all the more important internal organs.

For the possession of these parasites I stand indebted to Dr. John Anderson, F.L.S., Superintendent of the Indian Museum, Calcutta. I received them, with several others, on the 27th of September, 1875; and if I understand rightly, they together formed part of a much larger collection of entozoa, all of which have been secured by Dr. Anderson from hosts occupying the North-eastern Province of India. I may mention that the nematoid worms forming part of the contribution have already been described by me elsewhere; and, through the kindness of the donor, I am encouraged to look forward to the receipt of additional spe-

* In an Appendix to this paper I have also noticed a third species.

cimens, whose examination will in all likelihood yield interesting results.

The first trematode that I proceed to notice is the species termed *Distoma lancea* by the late C. M. Diesing. His description was based upon the examination of several parasites found by the Brazilian traveller Natterer. They were discovered in the biliary ducts of a male Dolphin dissected at Barra do Rio Negro on the 29th of December, 1833. Natterer calls this cetacean the Tacuschi, and in a letter to Diesing names the species *Delphinus tacuschi* in order to distinguish it from the *D. amazonicus* of Spix and Martius.

In all cases of parasitism it is desirable, when possible, to get accurate information as to the species of host infested. Accordingly I have sought Professor Flower's assistance; and he informs me that there are certainly two, if not three, species of Dolphin inhabiting the Amazons. In his paper in the 'Trans. Zool. Soc.' vol. vi. p. 87, he has shown that Spix and Martius's *D. amazonicus* is clearly referable to the Inia or Bolivian Dolphin (*Inia Geoffroyi*). Thus far the views of Flower, Natterer, and Diesing are in agreement; moreover the geographical position of Barra shows that the Dolphin in question could not be the Inia, since, as Blyth long ago remarked, this form "inhabits only the remote tributaries of the Amazon and the elevated lakes of Peru." Several other species from this river have been described, one of these being placed by Mr. Gray in a separate genus, and named by him *Steno tucuxi*. From the specific title there can, I think, be little doubt that Gray's cetacean answers to the *Delphinus tacuschi* of Natterer; but Professor Flower is of opinion that Gray's species is an ordinary *Delphinus*, in the sense in which that genus is now commonly restricted. In this case it may, he thinks, probably be referred either to the *D. fluviatilis* or to *D. pallidus*. Whichever view is correct, it is clear that Natterer's parasite was obtained from a thoroughly fluviatile cetacean, and not from an oceanic or even an estuary form.

From Diesing's original description, I am led to infer that Natterer had carefully examined several Dolphins, with negative results as regards the presence of flukes; at all events it is expressly stated that he found the *Distoma lancea* "once only," when numerous examples of the parasite were secured. Dr. Anderson's specimen was a solitary one, procured from the short-snouted Dolphin (*Orcella brevirostris*, Owen). He obtained it

on the 3rd of January, 1873. As it was removed from the duodenum, it might be expected to turn out a different species; probably it had escaped from the liver, the ducts of which may have contained others that evaded notice. Be that as it may, there can be no doubt as to the species, which is easily recognized by the fact that the body is irregularly serrated at its margin on either side below the ventral suckers. I know of no other trematode possessing these sinuosities. Dr. Anderson's parasite does not exhibit these irregular serrations so distinctly and sharply as the artist has represented them in Diesing's enlarged figures; but this may be due to the fact that the parasite is preserved in glycerine, which has certainly distorted the specimen. Without attempting any description of the anatomy of the worm, Diesing remarks that the internal organs may be seen through the transparent body. The uterine organs, crowded with ova and of a purple colour, are represented in his figures as forming a rather complicated rosette, branched after the fashion of a raceme. I have no doubt that the artist has been misled. He has represented its mode of termination above the ventral sucker quite correctly; but the uterine channel is not branched. I could not myself trace the passage towards its lower or ovarian end; but the upper uterine folds were few in number, broad, and simple in character. Diesing's figures give only obscure hints as to the situation of the remaining internal organs. Dr. Anderson's specimen showed two large irregularly oval testes placed one above the other in the middle line and rather higher up than is usual with those distomes that have the organs presenting this simple form. Its ducts were not visible. The yolk-forming glands are particularly well marked in Anderson's specimen, and consist of two laterally disposed masses, that on the left side reaching somewhat higher, whilst that on the right side extends correspondingly lower than its fellow. None of the vitelligene ducts were visible; but the so-called yolk-cells or capsules were well seen. The oval-shaped eggs were tolerably distinct and measurable, yielding a length of $\frac{7}{80}$ inch from pole to pole, by about $\frac{1}{30}$ inch in their transverse diameter. I could not get a clear view of the digestive canals; but, from the slight markings here and there noticeable, I feel tolerably sure that they conform to the ordinary unbranched type. I have represented their probable position and extent by a dotted outline. I saw no spines on the surface of the body; but the well-known tendency of these organs to fall off may have been the

cause of their apparent absence. As regards size, the shrivelled and shrunken character of the worm hardly permitted me to ascertain the length with accuracy. It did not, however, when unrolled, exceed one sixth of an inch at most, whereas some of Nattercr's specimens measured up to half an inch in length. The neck of my specimen had also entirely lost that full and rounded character which Diesing has so well figured and called skittle-shaped (*kegelförmige*). The ventral sucker is very nearly twice as large as the oral sucker, the former measuring about the $\frac{1}{8}\frac{1}{10}$ and the latter $\frac{1}{4}\frac{1}{2}$ inch in diameter from side to side. Diesing represents the ventral sucker as perfectly circular; but in Anderson's specimen this organ is broadly oval, the transverse diameter being longer than the vertical. The central cup is somewhat less than $\frac{1}{10}\frac{1}{10}$ inch in breadth.

The second trematode is one to which I am inclined to attach more importance, partly, no doubt, on account of the circumstance of its having been discovered by myself nearly twenty years since, but chiefly because the possession of many specimens has enabled me to acquire a much more accurate knowledge of its structure and affinities than that obtained in the case of *Distoma lancea*. In the 22nd volume of the Society's 'Transactions' I described a fluke of which I had secured numerous examples from the peripheral branches of the biliary ducts of a Porpoise (*Phocæna communis*). The cetacean was shot by Mr. Jardine Murray in the Firth of Forth in April 1855, and was regarded as a fine and healthy animal. I mention this because the bile-ducts were diseased in a similar way to that ordinarily observed in cases of rot affecting sheep, cattle, and other animals infested by flukes. In the original paper I did not perhaps lay sufficient stress upon the pathological facts that were observed by me at the time; but on referring to the manuscript notes still in my possession, I find it is stated that "the liver-ducts were in several places thickened and knotted near the surface of the organ. On opening these, they were found to be loaded with small distomata." It is added that whilst the flukes were alive they displayed, under the microscope, a "double and peculiar intestinal tube," the skin also being clothed with spines which are arranged throughout with perfect regularity. Unfortunately the day on which Mr. Murray sent the Porpoise was a Saturday; consequently my dissections were hurried, and the specimens were placed in strong spirit, which immediately destroyed their transparency. I was further embar-

rassed, inasmuch as Mr. Murray had also kindly sent a large number of birds for dissection (Guillemots, Gulls, and a Parrot-beaked Awk) at the same time. I may yet further supplement the originally published record by stating that, when the ducts lying immediately below the surface of the liver were dissected out, they presented a distinctly beaded appearance, the successive enlargements of the lumen of the ducts being occupied by flukes closely packed together. At least twenty were found in one spot. As no figure of these abnormal ducts was published, I subjoin an outline which is an exact reproduction of a sketch I made in my note-book during the dissection. Unfortunately the actual thickness of the walls of the ducts was not represented; but, from recollection, I can state that it was considerable.



Outline of an abnormally enlarged biliary duct. Nat. size.

The most striking feature connected with the structure of the worm was the regularly twisted condition of the digestive canals. They presented, in short, a zigzag appearance, the lateral folds being so angular when seen in profile that they seemed to constitute, as it were, a transition between the ordinary simple tubes of a true *Distoma* and the branched intestinal tubes seen in *Fasciola*. In this view it was that I placed the worms in a distinct genus, for which I proposed the term *Campula*. I now think that there was no sufficient ground for this generic separation, since, although in all the flukes which I have examined from *Platanista* the characteristic zigzag appearance is present, yet I find no trace of any attempt at branching. In all Dr. Anderson's specimens obtained from the liver-ducts of the Gangetic Dol-

phin more or less decomposition of the contents of the intestinal tubes has occurred; consequently the angular appearance of the folds is entirely lost, the margins looking uniformly rounded in profile.

From the other characters of the worms I cannot bring myself to believe that these flukes from the Ganges are specifically different from those obtained from the Firth of Forth. Nevertheless, in order to make sure that I had not exaggerated the angular character of the intestinal folds as they appeared in my original specimens from the Porpoise, I recently broke up a preserved microscopic slide, and, after soaking the specimens in glycerine, succeeded in bringing the digestive organs well into view, when they displayed precisely the same degree of angulation as the original figure in the Society's 'Transactions' shows. There were, however, no traces of rudimentary diverticula, such as I fancied I saw, but did not actually describe, in the original specimens. I now believe that the deceptive appearances were due to the sharpness of the turns or coils of the tubes, which in rather opaque objects is very apt to mislead. This is especially the case with the uterine folds, which, as in the case of *Distoma lancea*, have been represented as branched when perfectly simple. From a recent examination of my dried specimens of *D. crassum* I do not feel quite sure that I have not myself fallen into this error. Be that as it may, I desire (on the supposition of an error of interpretation of the facts) to restore my *Campula oblonga* to the genus *Distoma*, and I shall therefore in future speak of this parasite as *D. campula*, retaining the generic as an appropriate specific title. By this change I do not think that the morphological significance of the folded digestive tube is by any means lost. As obtains in the spiral gut of sharks and rays, the object of folding can only be to gain a larger extent of intestinal capacity without incommoding the animal and thereby interfering with its ordinary manner of life. In the members of the genus *Fasciola* and also in the allied Planarians this requirement appears to obtain its maximum. Here, however, even the additional surface gained by a spiral extension of the intestinal tubes appears to be inadequate, since to meet the demand we find the two main channels branched in a most striking manner.

I cannot here treat of this part of the subject to the extent it deserves; but in relation to the question of transition-forms I may remark that an extreme degree of folding seems as if it must,

when pushed further, result in branching. This, I think, would happen should any departure from the central distome type be rendered necessary by the exigences of the creature. At all events, the spirally twisted and branched digestive organs constituted different ways in which nature attains one and the same end. I may add that this coiled condition of the tubes in *D. campula* is by no means unique, since I have seen it slightly developed in other trematode forms, and very conspicuously so in a species (*D. compactum*) which I procured from an Indian Ichneumon, described to this Society in 1859.

Turning to the other internal organs, I have to state that whilst the flukes from the Porpoise only showed that the vitelligene glands were well developed and that the reproductive outlets occupied the usual position, Dr. Anderson's specimens have furnished a good general view of all the reproductive organs. In particular they show that the single, relatively narrow, and unbranched uterine canal is of great length and coiled upon itself in a singularly tortuous manner. In this way the duct passes from side to side, crossing the central line of the body at least a dozen times, whilst every fold is likewise bent upon itself to such an extent as to increase its length to at least four times that of the animal. In short, the uterine folds may be pretty accurately described as passing in a regular manner from side to side, each separate coil being very much twisted upon itself, thus frequently forming secondary coils. In the fluke here drawn (Pl. X. fig. 2) I have accurately represented every winding of the duct from its vaginal outlet above to its termination, where it is joined by the ovarian and vitelligene ducts in the ordinary way. Only the merest traces of these smaller channels, however, were here and there visible; but the two oval testes are conspicuous and well defined, occupying a position somewhat lower than usual in the typical forms of fluke. There was a third organ, apparently the ovary. This was less well defined, and situated higher up in the middle line. The vitelligene glands occupied the usual position; but their precise limits could not be accurately fixed throughout. The terminal cells or capsules with their efferent ducts were well seen in several specimens. Lastly, the water-vascular system was constantly visible, or at least that part of the main channel which expands into a large vesicle immediately above the central point of the tail. At this part several of Dr. Anderson's specimens had given way entirely, the parenchyma of the body, and sometimes the testes, bursting

through. In all of them the caudal end thus exhibited a sort of tail as a mere result of *post mortem* changes. None of the Edinburgh specimens displayed the slightest trace of this projection or of the water-vessel connected with it.

The other points remaining to be noticed may be dismissed in a few words. The uterine duct was well filled with eggs, but it was nowhere abnormally distended. Approximately the ova gave a measurement of $\frac{1}{1000}$ of an inch from pole to pole by $\frac{1}{2100}$ inch in breadth. Although in Anderson's specimens the integumentary spines had fallen off, they were still attached in the original specimens from Edinburgh, and measured on the average $\frac{1}{800}$ of an inch in length. With their shafts directed downwards, they separately presented the form of a long cone, the base of which was only $\frac{1}{1000}$ broad. Close to the apex each point of the spine curves gently upward. In connexion with the form of the parasite, I have only further to observe that the normal relative size and situation of the suckers is faithfully depicted from Anderson's specimens; but the tail end of the body is abnormally produced, from causes already referred to.

To conclude somewhat as I began, let me remark more fully upon the main points of interest suggested by these finds. So few in number are the students of helminthology that it need occasion no surprise if the internal parasites of cetaceans are little studied. Apart from what is stated in the writings of systematists (Rudolphi, Dujardin, Diesing, &c.), we have but few and scant notices of cetacean parasitism. The most important contribution is by Professor Van Beneden ('*Les Cétacés, leurs Commensaux et leurs Parasites*'). The Belgian helminthologist evidently desired to render his list of the parasites as complete as possible; nevertheless, extended as his record is, he neither notices *Campula oblonga* nor the remarkable cestode discovered at the same time. Mr. Murray's porpoise not only yielded numerous flukes, but it played the rôle of host to five large tape-worms (*Diphyllbothrum steenmacephalum*) and to multitudes of nematodes infesting the bronchi, the pulmonary vessels, and the heart (*Prosthecosacter inflexus* and *P. convolutus*). Other parasites were detected in the stomach; but I referred them to the partly digested fishes whose remains accompanied them. Van Beneden points to a paper by Lebeck describing a round worm from the stomach of a Gangetic Dolphin (*Ascaris delphini*). Dr. Anderson also found nematodes in the intestines of *Platanista*; but these correspond with

the *A. simplex* of Dujardin. On this head I will only add that cetaceans are evidently very much victimized by parasites, both by attacks from within and without ; and it is clear that our knowledge of the species is exceedingly imperfect.

On *à priori* grounds it might be supposed that aberrant cetacean hosts would be likely to yield correspondingly aberrant parasitic types. This is not the case, however, either as regards the flukes and nematodes, or, indeed, as regards the cestodes, to any very marked extent. The explanation is not far to seek ; for however divergent particular hosts may be, mere morphological changes in their organs will not of themselves materially alter the conditions of the parasite's existence. To be sure, in the case of the liver-infesting flukes, the mere size of the biliary ducts will tend to modify the size of the parasite ; but it is incapable of altering the type. Thus the common liver-fluke attains very much smaller proportions in the hare and rabbit than it does in the donkey and ox ; but the essential generic character seen in the branched intestine is strictly maintained. Again, the liver-fluke of the giraffe, if it in any degree coordinated with the aberrant characters of its host, would, we might presume, exhibit departures from the type still more marked. The facts, however, show that the only marked differences between the giraffe's *Fasciola* and the ordinary fluke refer to external configuration. Even the liver-fluke of the elephant (*F. Jacksoni*), the shape of which presents a striking contrast with that seen in the Ruminants, still displays the branched intestinal canals, and that, too, in such a manner as to suggest the closest alliance with the Planarians. As I have shown in my communication "On the Destruction of Elephants by Parasites" (The Veterinarian, 1875), the mud-swallowing habits of these huge hosts are eminently favourable to the introduction of fluke-larvæ ; and it is worthy of remark that the intermediary bearers likely to be thus swallowed abound in just those very localities where Planarians have their head quarters.

If my argument is sound, it is clear that neither *Platanista* and *Orcella*, on the one hand, nor *Inia* and *Delphinus*, on the other, need be expected to yield fluke-parasites generically differing from those found in *Phocæna* and other cetacean types. Even wide differences of geographical distribution do not appear to exert any very marked change ; and this is the more remarkable since such variations of habitat by the host might be expected not only to supply

new and peculiarly modified intermediary bearers, but also in other ways to alter materially the conditions of existence. Without a doubt some fluke-parasites are confined to particular localities; and this is solely due to the fact that their bearers and intermediary bearers are alike restricted to a limited territory. But for these restrictions, there is good reason to fear that (as in the case of *Bilharzia*, for example) several of the most terrible endemic disorders, now confined to limited areas, would become world-wide. Fortunately for them, the lower animals are much more capable of resisting the untoward effects of parasitism than ourselves. We, however, have the power of warding off most of the dangers from this source, since we are now in a position to adopt preventive measures. This is entirely due to the advance of helminthology. As regards domesticated animals, it may probably be said with truth that they suffer from entozoa more than wild ones. In the course of a large experience, however, I cannot say that I have found wild animals very much less infested. With the multiplication of beasts of burden and other serviceable quadrupeds there have also arisen greater facilities for infection; and if, as unfortunately seems to be the case, parasitism amongst domestic animals has increased rather than diminished, it is because those who possess the power to put a check upon these disorders have not thought it worth their while to obtain special information on this head.

As regards wild animals, it is well nigh impossible to acquire correct data as to the destructiveness of parasites. I have no hesitation in saying that half the amount of parasitism that I found in Mr. Murray's porpoise would have killed any ordinary domesticated animal. Our cattle and sheep are carried off by thousands by much less formidable lung-parasites than that cetacean harboured. Doubtless wild animals, cetaceans amongst them, becoming at length weakened by their parasitic guests, more readily succumb to their various other enemies, which, in the struggle for existence, are only too ready to reap the desired advantage. On the other hand, I have little doubt that the porpoises and seals that have died at the Zoological Gardens, and whose lungs were largely infested by parasites, would, in their natural haunts, have borne up against the evil effects of a much larger amount of parasitism than they were enabled to do in confinement. One conclusion, at all events, is inevitable, namely that endemics, epidemics, or epizootics of the parasitic kind, call them what we may, are for the most part

due to the excessive multiplication of particular helminths during certain seasons. As obtains in non-parasitic plagues of all sorts, there is a perpetual rise and fall in their prevalence; and this is simply due to the presence or absence, as the case may be, of favourable conditions. This is the general explanation of the irregularity observed in the periodical return and degree of virulence of the grouse-disease, which I hold to be due to parasites. The same explanation holds good in the case of the disorder I have termed *Olukaniasis* in cats, also in that of a nemato-helminthiasis affecting pigeons, due to *Ascaris maculosa*, also of a similar epizooty occasioned by the four-spined Strongyle (*S. tetracanthus*) infesting the horse, also of the well-known parasitic bronchitis caused by Strongyles in lambs and calves, also of a like disease occasioned by *S. commutatus* which sometimes carries off hares in great numbers. In short, this explanation applies to many other more or less clearly defined parasitic maladies. Flukes, generally speaking, are comparatively harmless. As a rule, and with some few and notable exceptions (*Bilharzia*, &c.), only such of them as occupy the liver are capable of doing serious harm to their bearers, whether wild or domesticated. That their presence in the liver of cetaceans is capable of setting up an unhealthy action is abundantly proved by the facts incidentally noticed in this paper. The whole subject of animal parasitism is one of increasing interest—zoologists, physiologists, and sanitarians being equally interested in its revelations. This consideration must serve as my excuse for noticing some of the practical points suggested by the study of these dolphin-trematodes.

Appendix.

Since the completion of this paper I received a letter from Dr. Anderson enclosing "a drawing of a parasite, enlarged 28 times, from the small intestine of *Platanista*." The drawing had been overlooked, but was fortunately found by Dr. Murie amongst some loose papers. Judging from the illustration (here reproduced), this is another distinct species of cetacean trematode, and at present new to science. When I received the specimen Dr. Anderson was making preparations to leave England; but in reply to my inquiries, he found time to inform me in a second letter that the host was a different individual from that which yielded *Distoma campula*. He obtained the new parasite in

March 1873. In this case there does not appear to have been more than one parasite present in the intestine. There is certainly something very peculiar about the head and neck of this fluke; but assuming that it was not in any way injured before the drawing was executed, I offer provisionally for its recognition the following nomenclature and characters.

DISTOMA ANDERSONI, n. sp. Body oblong, smooth externally, uniform in thickness, six times as long as broad; head with lateral projections; ventral sucker large and prominent; neck much constricted; tail evenly rounded off, blunt. Length $\frac{1}{8}$ ", breadth about $\frac{1}{10}$ ".

In addition to the above-mentioned characters, the drawing shows that the testes are globular and placed high up in the middle line of the body. The small lobed gland immediately above them is probably the ovary. The clear narrow line extending from the border of the lower testis to the end of the tail seems to mark the limit of the vitelligene organs on either side below. These glands in all likelihood extend upwards to the neck, being apparently very largely developed in this species.

EXPLANATION OF PLATE X.

Fig. 1. *Distoma lancea*, $\times 70$ diameters.

2. *D. campula* (= *Campula oblonga*, Cobbold), $\times 50$ diam. (The small letters refer to the same parts in these two different species.) *a*, oral sucker; *b*, ventral sucker; *c*, reproductive papilla; *d*, œsophageal bulb; *e*, œsophagus; *f*, intestinal tube; *g*, caecal end of the same; *h*, testes; *i*, ovary; *k*, vitelligene gland; *l*, uterine canal; *m*, trunk of the water system.
3. *D. Andersoni*, $\times 28$ diam. *a*, oral sucker; *b*, lateral prominence of the head; *c*, ventral sucker; *d*, neck; *e*, œsophageal bulb; *ff*, body; *g*, ovary; *h*, testes; *i*, central clear line; *k k*, vitelligene gland of one side; *l*, water-vascular outlet.

